Space Weather Technical Forecast

Issued on Monday, 11 July 2022 at 01:22 Local

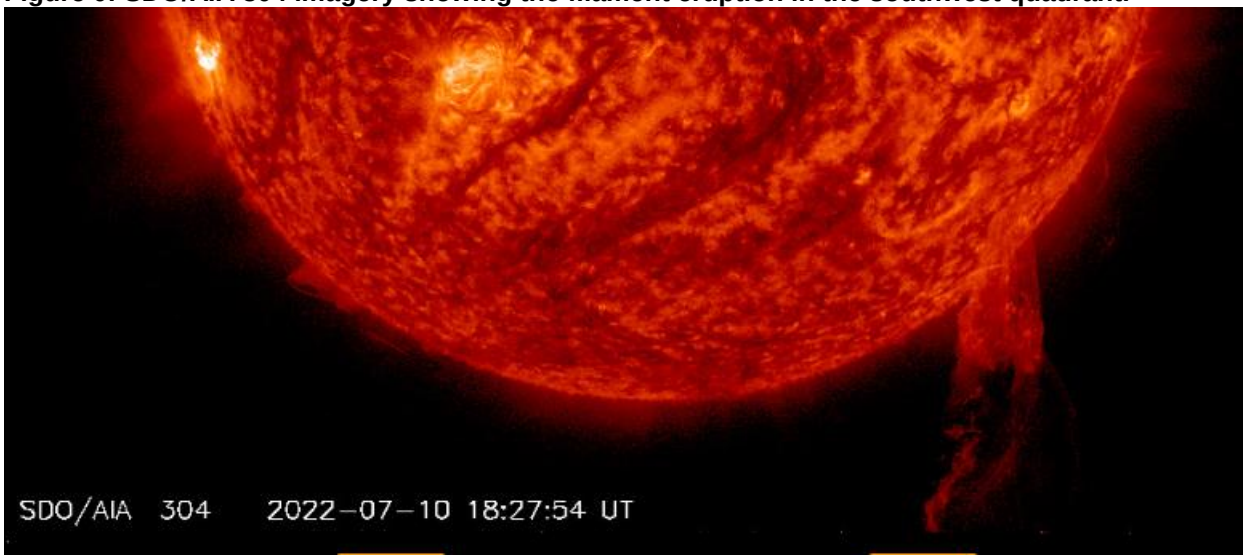
This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Chance of further M-class flares and R1/R2 Radio Blackouts. Chance of G1/Minor Storms mainly day 3 (13th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low, despite a slight rising trend in background level and some occasional C-class flares. The most recent was a C4 peaking at 10/1810 UTC and originating from a new region in the southeast quadrant. A filament lift-off was also observed around 10/1700 UTC, which resulted in a CME visible off the southwest limb. The results of the analysis are not yet fully known but it is not considered to be Earth-directed.

Figure 0: SDO/AIA 304 imagery showing the filament eruption in the southwest quadrant.



There are seven numbered sunspots on the disc, two of which are unnumbered. AR3055 remains the largest and most complex region. It is becoming more and more elongated, with proliferation of intermediate spots. The next largest region is AR3053. It has not changed much since the last analysis and has decreased further in size, with the disappearance of a few spots in its central part. AR3046, AR3052 and A3052 appear relatively unchanged or slightly decaying. Two new regions, both simple, have recently appeared on the eastern limb. The first one, in the southeast quadrant is growing in size, with proliferation of spots. The other one, in the northeast quadrant, is a unipolar region.

There are currently numerous large filaments on the Sun, with the southeast quadrant in particular harbouring two large features that each span roughly 20 degrees on the solar disc. There were no signs on instability in these in the reporting period, however they will become increasingly relevant should they lift off in the coming few days, and will be monitored.

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Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, remained slow-ambient and between 340-380km/s, although a couple of SSBC enhanced the speed to 400km/s for a time, whereas the phi angle was mostly positive (away from the sun). The solar wind density was largely Average but rose slightly above between the two SSBC. Equally, the IMF was weak but became occasionally moderate between 10/0800-1400 UTC, reaching a maximum of 11nT by 10/1100 UTC, while the north-south component ranged between +7 and -8nT whereas it was negligible outside of these times. The net result of the above solar wind measures was Quiet for much of the 24 hours, with a provisional Kp3 in the 06-09UTC window.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, is back to background levels and on a decreasing trend, after it became enhanced in the wake of the C8.5 flare that occurred on the 09th.

The high energy electron flux (greater than 2MeV) remained at Normal Background levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold on a roughly level trend. Observed fluence was 1.62e6 integrated pfu at 11/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain Low, but with a daily Chance of M-class flares. A progressive slight increase is possible in the four days, with the sunspots that present the greatest risk of flares still in the eastern solar hemisphere, possibly bolstered by further arrivals over the northeastern limb into the new working week UTC.

Solar Wind / Geomagnetic Activity: A glancing blow from a CME may affect Earth late today (11 July) but confidence is low. Another and more prominent CME may arrive at Earth at the end of day 2 (12th). Solar winds may become enhanced today, under the influence of the HSS from CH99/+, and stay elevated through much of the forecast period. Geomagnetic activity is expected to be largely Quiet to Unsettled with a chance of an Active interval on days 1 and 2 (11th and 12th) but to become increasingly Unsettled and Active at the end of day 2 and into day 3 (12th and 13th), with a significant Chance of G1/Minor Storms under the influence of the CME that left the sun late on 9 July.

Energetic Particles / Solar Radiation: Unless there is significant sunspot development, the high energy proton flux (greater than 10 MeV) is likely to remain at Background levels. There is however a daily Slight Chance of S1 or greater, due to the presence of two relatively large sunspot regions over the eastern hemisphere.

The high energy electron flux (greater than 2MeV) may increase at the end of this period, but the corresponding fluence is expected to remain well below the Active threshold (1e8 integrated pfu).

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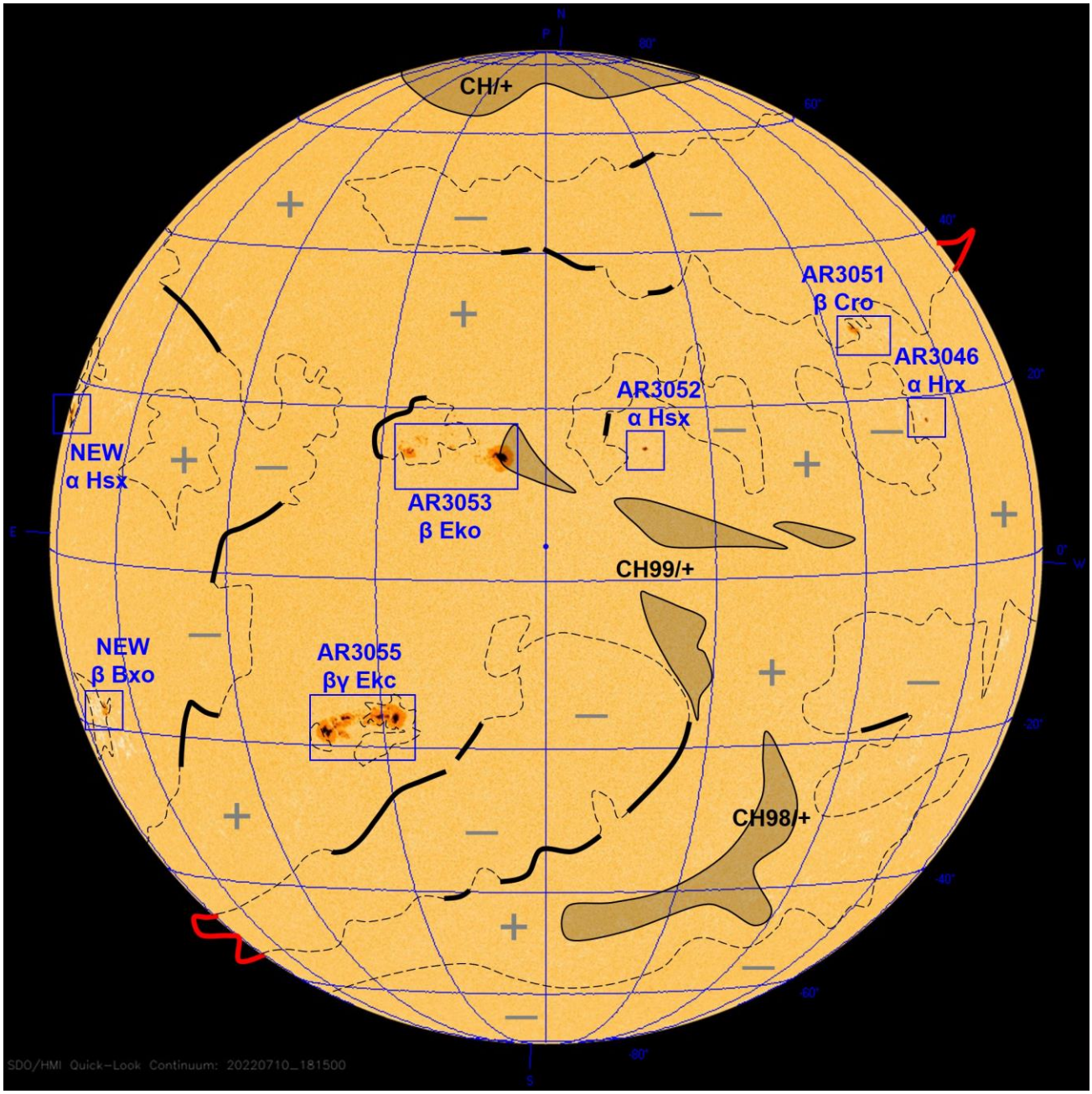
Figure 1. Solar Analysis Valid 10/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A large CME was observed leaving the sun in the late hours of the 08th, in association with a long duration M2 flare. Its analysis revealed that while the bulk of the ejecta is expected to miss behind Earth's orbit, there is a slight chance of a glancing blow today (11th). Another CME was also observed, this time in the late hours of the 09th and originating AR3052, which was near the central meridian at the time. This CME is expected to be much more prominent and should arrive at Earth on day 2 (12th).

The solar wind is at slow-ambient levels. The next coronal hole worth of note is the very fragmented CH99/+. It is a recurring feature that generated speeds of 600km/s on the previous rotation, however, due to its smaller size and fragmentation in the intervening month, it is hard to envisage similar will be achieved this time around.

STEREO A does show an analogous enhancement in recent hours associated with a positive phi angle, which would correlate to an arrival at Earth on Monday 11 July which would be 24 hours earlier than expected versus SWPM. CH98/+ may contribute to this enhancement however its input is considered minor, being further away from the Earth ecliptic latitude.

Geomagnetic activity is expected to be largely Quiet to Unsettled with a chance of an Active interval on days 1 and 2 (11th and 12th) but to become increasingly Unsettled and Active at the end of day 2 and into day 3 (12th and 13th), with a significant Chance of G1/Minor Storms under the influence of the CME that left the sun late on 9 July.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	50	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/0047 UTC	Partial Halo	AR3053	NE quadrant	1072 km/s	11/1800 UTC +/-6 hrs	Limited shock
10/0500 UTC	Partial Halo	AR3052	NE quadrant	918 km/s	12/2200 UTC +/- 6 hrs	More prominent shock

Figure 2: Enlil showing the bulk of the second CME hitting Stereo A

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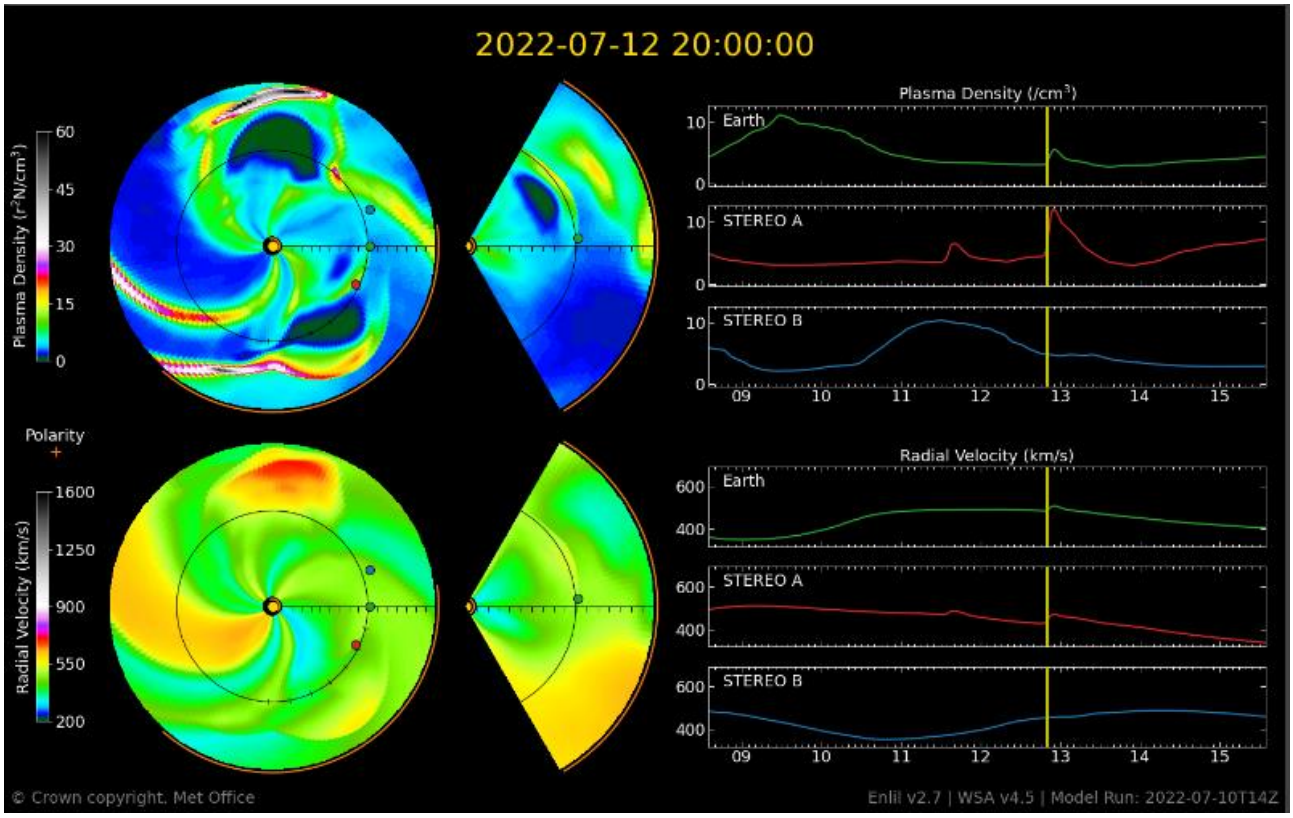
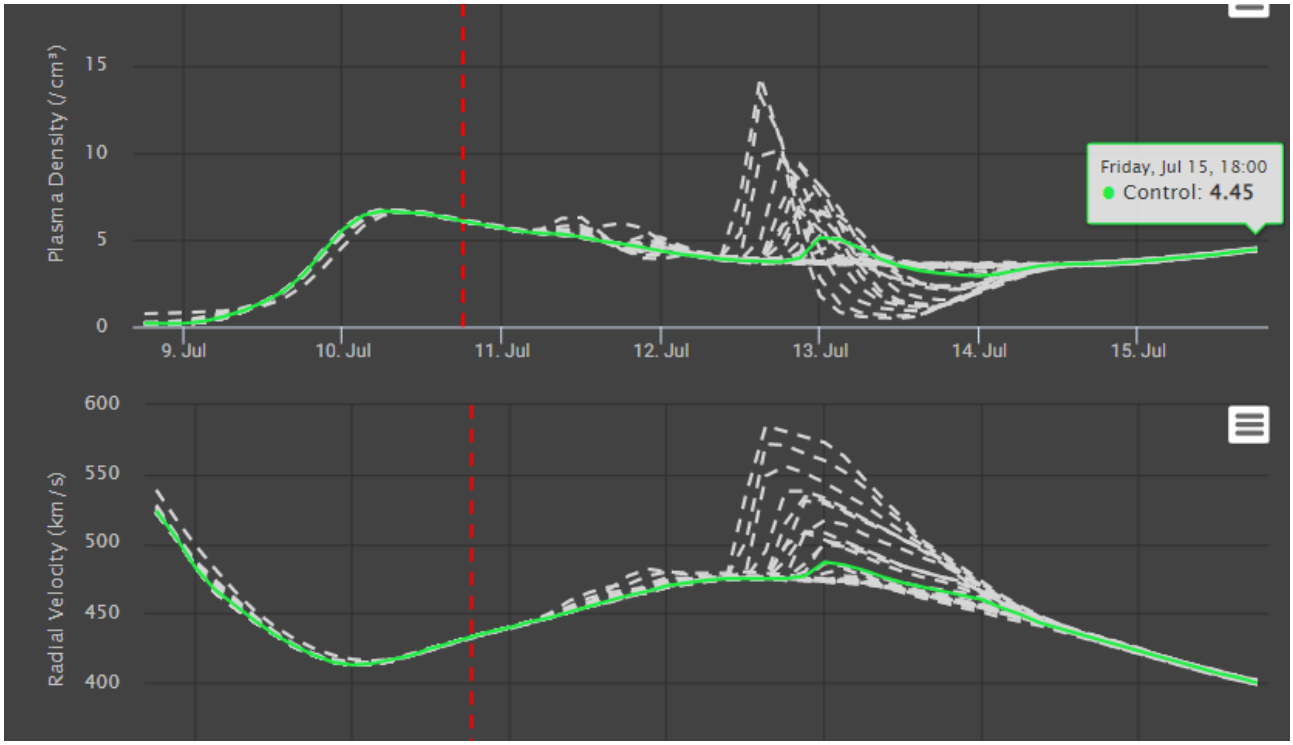


Figure 3: Ensembles showing a more significant hity from the second CME



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Radio Blackouts - X-Ray Flares:

Solar activity was Low, despite a slight rising trend in background level and some occasional C-class flares. The most recent was a C4 peaking at 10/1810 UTC and originating from a new region in the southeast quadrant.

There are seven numbered sunspots on the disc, two of which are unnumbered. AR3055 remains the largest and most complex region. It is becoming more and more elongated, with proliferation of intermediate spots. The next largest region is AR3053. It has not changed much in the last 12 hours and has decreased further in size, with the disappearance of a few spots in its central part. Both regions are perhaps slightly under-active for their class on paper. Despite this, a daily Chance (40-50%) of further M-class flares is considered probable.

Solar activity is Likely to remain Low, but with a daily Chance of M-class flares. A progressive slight increase is possible in the four days, with the sunspots that present the greatest risk of flares still in the eastern solar hemisphere, possibly bolstered by further arrivals over the northeastern limb into the new working week UTC.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	15	15	15	15

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is now back to background levels, after it became slightly elevated on the 09th (in response to a C8 flare). Flux levels are therefore starting from a slightly higher baseline, with two relatively large sunspot regions transiting over the eastern hemisphere. The risk of an S1 in the next four days is therefore considered greater than previous guidance, with the upward tendency in risk perhaps approaching 10% towards midweek.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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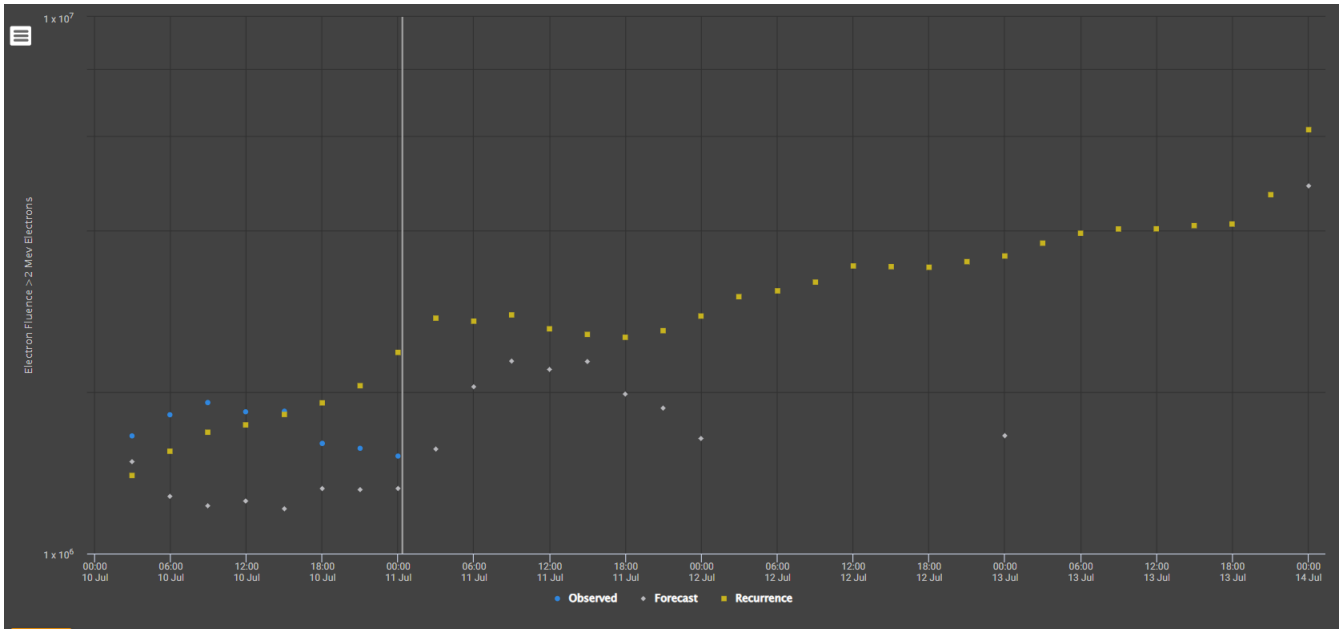
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) is currently at Normal Background levels. While CH99/+ is a recurring feature, it is much-changed in comparison with the previous rotation and as such, confidence is relatively low. The expected arrival of the high speed stream and a Slight Chance of a G1 ought to prevent any significant increase in flux levels over the next few days, at least until midweek when a new equilibrium can be achieved.

The corresponding fluence is therefore very unlikely to exceed the Active threshold (1e8 integrated pfu) during this period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest REFM output, considered to guive good guidance



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